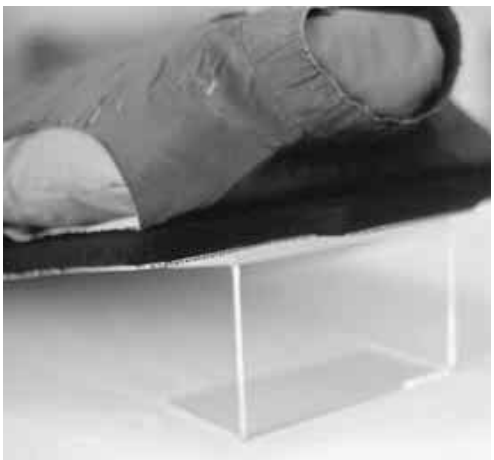

Inaugural vest worn by George Washington, Morristown National Historical Park. Acrylic support in place while artifact is on exhibit.

garments on special occasions for a short period of several weeks. The garments were too fragile to display on a mannequin or even to be handled frequently, so it was necessary to develop a passive system of mounting and storage that eliminated the need for direct handling. A base support was developed for each of the three pieces. This consisted of rigid archival boards cut close to the shape of the objects, each was slightly padded with polyester batting and covered with cotton fabric. An interior support pillow made from nylon fabric with polyester batting was placed into the clothing. The smooth surface of the nylon allows the pillow to slide in place without excess friction on the artifact and the batting will not collapse over time. While in storage, the clothing lays flat on the support. When the park wishes to display one of the garments, the board is placed on exhibit and raised for viewing by placing an acrylic wedge under the board to allow a viewing angle of 15 degrees.

A similar passive support was also utilized on a silk velvet vest in the collection of Andrew Johnson National Historic Site, Tennessee. Upon completion of the conservation treatment, a storage box was made to house the vest. An interior pillow support was fabricated from nylon fabric and polyester batting. This was placed in the vest to provide support for the velvet and prevent any creases from forming.

Textile conservators use a variety of techniques to support and display objects. When possible a passive support system is chosen. While providing a three-dimensional appearance to the object, passive mounting techniques also provide support to the object. This system allows easy exhibit rotation and eliminates the need for direct handling of fragile artifacts. Combining these two preventive conservation factors provides for both the exhibit and storage needs of the object.

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Photos courtesy the author.

Barbara Cumberland

Using Freeze-dried Animal Specimens in Exhibits

The use of freeze-dried animal specimens in National Park Service exhibits became popular in the late-1970s through the mid-1990s. Freeze-drying animal specimens for display purposes is an alternative to conventional taxidermy techniques or fabricating models out of synthetic materials. This article will deal with the use of freeze-dried specimens acquired for national park museum and visitor center exhibits as opposed to their use in scientific study collections in museums.

Conservators at the Harpers Ferry Center Division of Conservation are often called upon by park staff to answer questions about their museum collections. In the mid-1980s, the number of park inquiries about evidence of insect infestation and deterioration of freeze-dried specimens in exhibits increased.

Freeze-drying technology

The Smithsonian Institution popularized freeze-dry technology on natural history specimens for museums in the 1950s. It was a quick, effective technique for interpreting accurate animal forms. Freeze-drying converts water in the specimen from its frozen state directly to its gaseous state, a process called sublimation. Animals are first frozen into a desired position (held by wiring or propping) and then placed in a vacuum chamber at -15˚C to -20˚C. Ice crystals

are allowed to sublime from the specimens, which results in minimal distortion. In most cases, body organs are retained, although sometimes the animals are first eviscerated (the preferable option). Freeze-drying has an advantage over conventional taxidermy of ease and inexpensive labor costs, although the product is not always less expensive. Freeze-drying can give a more realistic appearance on small, delicate specimens than traditional taxidermy. Although freeze-dry preparators do not readily admit the possibility that incomplete drying and rehydration can occur, there have been many reports of this happening in national parks and other museums. Incomplete sublimation occasionally occurs in larger specimens, sometimes causing brittleness of the outer surfaces, while some internal tissue may still contain its original 90% moisture content. Incomplete drying can be a more likely cause of tissue decay than exposure of specimens to high humidity on display.

The success of an exhibit of freeze-dried materials depends on understanding the limitations of the process, a commitment to maintenance, and proper exhibit design. Contrasted with conventional taxidermy, freeze-dried material is more porous and brittle, and vulnerable to insect attack, biodeterioration and oxidation. Specimens are collapsible and easily scarred if handled improperly.

In animals with a naturally excessive fat and oil content (generally all those that live near water), there may be fatty acid damage because lipid oxidation and degradation occurs when materials are frozen. It can attack the skin, deteriorate protein and go rancid. Microorganism attack follows. Conventional taxidermy is recommended over freeze-drying for fatty and large specimens. Freeze-dried specimens should always be isolated from collection objects to avoid contamination by migration of fats and oils.

Freeze-dried specimens are especially attractive to protein- and keratin-eating insects such as clothes moths and dermestids (carpet beetles and hide beetles), and insect attack is highly probable in unprotected specimens. In the past, some taxidermy specimens were protected from persistent infestation with Edolan U, a mothproofing pesticide (the only pesticide that seemed to work for freeze-dry preparators), but it is no longer on the market and has not been replaced. Well-sealed exhibit cases, combined with periodic pest inspections by trained staff, are the best protection available to parks.

Freeze-dry preparators often recommend either routine (once/year) refreezing of specimens for pest control, or the inclusion of a vapor phase space fumigant such as paradichlorobenzene, naphthalene or dichlorvos (Vapona strips) in a sealed exhibit case with the specimens. However, the NPS does not endorse this fumigant approach in most instances. The use of vapor phase fumigants is now discouraged for health reasons and because they react negatively with museum objects and materials.[1] Park personnel must first request review and approval for any pesticide use from their Central Office or Washington Office Integrated Pest Management (IPM) Specialist. In response to signs of infestation or as a preventive measure, cleaning the case with a nozzle attachment vacuum and the use of a crack and crevice treatment using diatomaceous earth or Tri-Die((silica aerogel containing pyrethrum) may be considered. As part of the park's IPM pest monitoring program, using sticky traps with pheromone lures[2] for webbing clothes moths and varied carpet beetles is effective for early detection in the exhibit space.

To kill all stages of insect pests in freeze-dried mounts, a controlled re-freezing[3] is most often recommended both as a preventive measure and a response to pest evidence. After freezer treatment, any insect evidence is removed from the object mechanically and the specimen is assessed to determine the extent of damage. It may be cleaned, conserved, and re-used if damage (e.g., loose or lost fur or feathers) is minimal. All freezing and conservation details should be documented and kept with the object's permanent records.

There are other methods of disinfesting specimens such as suffocation by various anoxic fumigation methods, toxic vapor phase fumigation, and a newer procedure of plasma field sterilization under vacuum. Freezing is more practical for park staff and many museums because it requires less specialized equipment, and if done correctly, is as effective, cheaper, and safer. It offers no residual protection, although freezing can lower the moisture level in the specimen making it less appealing to insects.

Re-freeze-drying has been recommended when there is moisture regain in the specimen, because freezing itself will not solve the problem. Specimens should not be saved once tissue decay has begun. Strong odors can be a warning sign of deterioration, although the animals can normally have their own peculiar odors.

As with conventional taxidermy, freeze-dried mounts can potentially be damaged and change color at high light levels. Exhibit lighting should be filtered for UV, with 3-15 foot-candles as the recommended light level.

Surveys of NPS Sites with Freeze-dried Taxidermy Specimens

In January 1991, all 16 parks[4] with freeze-dried animals in their exhibits were surveyed to find out if they were experiencing any maintenance problems with the exhibits installed between 1978 and 1990. The survey was updated in March 1999 and 24 parks were contacted[5] that had these kinds of specimens on exhibit (the same parks contacted in 1991 and all others known to have freeze-dried exhibits installed since 1990). Details of the survey questions and results may be requested from the author.

The 1999 survey indicates eight parks reporting no problems with their freeze-dried specimens, while 16 reported that there have been instances of insect infestation, damage and tissue decay. The fact that two-thirds of the parks with freeze-dried specimens reported extensive problems is alarming.

Some parks have open dioramas. Parks claiming well-sealed exhibit cases tended to report fewer insect incidents. None of the parks presently have a fumigant included in the cases with the specimens although one had Vapona strips and one had paradichlorobenzene cakes included at installation. These fumigants were since removed when no longer recommended or available for museum use.

Pests identified in the park surveys included dermestids (varied carpet beetles, buffalo carpet beetles, Trogoderma sp., and unidentified); clothes moths (webbing clothes moths and case-making clothes moths); fungus and stored product beetles (confused flour beetles, rove beetles and minute brown scavenger beetles); psocids, fly maggots and cockroaches. Pest evidence included frass and dust on and beneath specimens, cast larval skins, live and dead insects and larvae, holes, hair loss, feather damage and loss, holes in beaks, skin eaten off feet, specimens eaten from inside out, etc. Reported evidence of rehydration and tissue decay included bad odor, mold, and rotting lesions. In several instances, all freeze-dried specimens at a park eventually needed disposal and replacement with non-freeze-dried options.

The freeze-dried animals in the parks found with pest evidence/damage or tissue decay included owls, turkey vultures, herons, turkey, bald eagles, hawks, ducks, waterfowl, other birds, rat, skunk, raccoons, squirrels, rattlesnake, black bear cub, dungeness crabs, opossum, coyote, badger, prairie dogs, bobcat, muskrat, nutria, otter, mink, weasel, armadillo, baby deer, small alligator, turtle, fish, beaver and wolf. Many of these animals are larger than the size we now recommend for freeze-drying (squirrel or smaller), and some are fatty animals such as those that lived around water.

Case Study

My interest in this subject was rekindled when I did an on-site conservation project at the Alaska Public Lands Information Center in Anchorage in 1997. Their visitor center has many freeze-dried and conventional taxidermy mounts and fish models, both in exhibit cases and out on open display. During my visit, the park replaced two freeze-dried dungeness crabs that were infested with webbing clothes moths and very odorous from tissue decay. The taxidermist who had prepared them provided free replacement freeze-dried crabs to be reinstalled in the closed exhibit cases. Within one year, the new dungeness crabs were infested with dermestid beetles, Anthrenus scrophulariae (Buffalo carpet beetle). The case is not insect-tight but it is also possible that dermestid eggs or larvae were present inside the crabs at installation. After the initial infestation, I recommended that if the crabs ever needed replacement again, synthetic models be made instead of using freeze-dried specimens. This was done in 1998. This visitor center also lost a freeze-dried black bear cub and an eagle to separate webbing clothes moth infestations. The eagle also had minute brown scavenger beetles associated with it. Those specimens were not enclosed in exhibit cases.

The exhibit design here is a clear instance where infestations of individual freeze-dried spec-

imens are a great threat to the other freeze-dried and conventional taxidermy specimens on open exhibit and within cases, and also to sensitive ethnographic collections that are in separate exhibit cases. I had carefully inspected and cleaned the taxidermy specimens during my visit to the park, and advised on a pest management strategy to prevent the spread of infestation. The specimens require close and frequent inspection, and a pest monitoring program that includes sticky traps with webbing clothes moth pheromone lures. When the pest evidence was discovered on the eagle, the evidence was saved for identification, the eagle was sealed in a plastic bag and frozen to kill the pests. After freezing, when the conservator examined the eagle it was found to be too damaged (feather loss, holes) to save. It will be replaced with a specimen prepared by conventional taxidermy and enclosed in an exhibit case. The park is considering changing the exhibit design in the future to include enclosing all specimens in well-sealed exhibit cases.

Recommendations

For very long-term exhibits featuring animals, the best solution may be the use of models fabricated from synthetic materials. While slightly more expensive initially, replacement costs of deteriorated or infested specimens are unlikely to be a factor with fabricated models. It also has the advantage of not harvesting animals from the environment and being less of a maintenance challenge. There are a growing number of exhibit studios that have the ability to produce high quality models. The NPS now uses models for all exhibits with fish.

If a park or their exhibit designers decide to use actual non-living animals in their exhibits, they need to make an informed decision between using conventional taxidermy or freeze-dried taxidermy specimens. The method of preparation should be suited to the particular specimen to be preserved and the exhibit circumstances. Conventional taxidermy is preferred in most instances, especially open displays. It has the advantage of lasting longer, reduced insect vulnerability and reduced humidity sensitivity.

Conventional taxidermy preparation should be used instead of freeze-drying when any of the following conditions exist:[6]

- Specimens are large (larger than a squirrel or songbird)
- Specimens have high fat content (e.g., ducks, fish, otters, beaver, etc.)
- Open displays are to be used (no exhibit cases)
- Ambient humidity levels are likely to be high (above 55% RH)
- Exhibit is long-term

Because the statistical evidence from the 1999 survey showed significant pest and biodeterioration problems in two-thirds of the 24 national parks with freeze-dried exhibits, I tend to advise against the acquisition and use of freeze-dried animals in future exhibits. In instances when the freeze-dried specimens need to be replaced, the replacement specimens should be either models or conventional taxidermy.

For parks with exhibits of freeze-dried animals in less-than-ideal conditions such as open dioramas or poorly sealed cases, it is important to be especially aware of the limitations of the specimens and have a good pest management program in place. Replacement costs are often incurred when the exhibits are expected to last a long time. These displays will always require maintenance, cleaning, and frequent inspection.

Notes

1 Anthony M. Knapp, *Conserve O Gram*, 2/4, "Dichlorvos (Vapona) Update." 1993.

2 Source: Fumigation Service & Supply, Inc. Phone: 800-992-1991.

3 Raphael, Toby, *Conserve O Gram*, 3/6, "An Insect Pest Control Procedure: The Freezing Process." 1994.

4 Alaska Public Lands Information Centers- Anchorage and Fairbanks, Big Cypress NP, Bryce Canyon NP, Cape Cod NS, Devils Tower NM, Effigy Mound NM, Everglades NP, Glacier Bay NP, Great Smoky Mountains NP, Gulf Islands NS, Jean Lafitte NHP, Joshua Tree NP, Rock Creek Park, Voyageurs NP, and Yellowstone NP

5 The National Parks above (4) and also: Big Thicket NP, Buffalo River NP, Glacier NP, Guadalupe Mountains NP, Harpers Ferry NHP, New River Gorge NR, Sleeping Bear Dunes NL, and Theodore Roosevelt NP

6 *Exhibit Conservation Guidelines- Technical Note* 1:8, "Selecting Taxidermy Specimens for Exhibit". Division of Conservation, Harpers Ferry Center, National Park Service. CD-ROM, 1999.

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